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AUTHOR Chew, Robert L.
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ABSTRACT

Reasons for distributed systems (DS) of planning and design for information services for colleges are discussed. The methodologies and approaches from industry and academe are contrasted to show how the process of DS can be effectively managed to meet a variety of institutional needs. DS represent a natural evolution of the historic development of data processing, from its cycles between centralized and decentralized equipment and operations. An industrial DS planning methodology is outlined that involves five processes: identify DS goals and objectives, determine DS problems/opportunities, apply DS concepts and technology, select DS applications, and apply the DS development process. Academic institutional planning approaches for communications and distributed processing are addressed. At Bentley College (Massachusetts), the following issues are being examined: the mission and operations of the college in relation to information services; future directions; strategies and programs for achieving goals; and the costs involved. It is noted that a pilot local area network has been implemented as the first phase of an integrated communications network for the campus. Technical and management issues that need to be resolved are also identified. (SW)

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PLANNING FOR DISTRIBUTED SYSTEMS

Dr. Robert L. Chew
Associate Professor, Computer Information Systems
Bentley College
Waltham, MA 02254

Abstract

Most academic institutions have not devoted sufficient time and resources to information services planning. It is critical to do so now, both for financial advantages and long-term commitments needed to implement networks of distributed processing components. Some of the main motivating factors for distributed systems will first be discussed. Then methodologies and approaches from industry and academe will be contrasted to show how the processes of distributed systems planning and design can be effectively managed to meet a variety of institutional needs. Finally, issues and implications for the planning and design of distributed systems will be raised.

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PLANNING FOR DISTRIBUTED SYSTEMS

A. Introduction

A variety of complex distributed information systems are now operational in many industries and financial organizations. These systems are comprised of multiple-vendor hardware and software components, private and public national networks, and local area networks supporting transaction processing and office automation activities using many data base management techniques. Some of these models have been well-planned and designed; most have been experiments or have just evolved as needs arose.

This industrial experience in planning and developing distributed systems can be adapted to the college and university environment. Whereas national or regional networks have been the basis for industrial distributed systems, the academic environment requires a local area network with interfaces to regional and national data resources.

Academic and administrative requirements for information systems suggest increasingly integrated technological solutions to: access a variety of computer-based resources, perform word processing, link thousands of student personal computers, transmit A/V to classrooms, and perform energy control and security monitoring of facilities.

B. Motivations for Distributed Systems

Let us first define what we mean by distributed systems. More than just an application utilizing multiple processors, the term "distributed systems" represents a natural evolution of the historic development of data processing, from its cycles between centralized and decentralized equipment and operations. During the past few years, distributed systems or "distributed data processing" has been evolving as a management philosophy and mode of operation in the large corporate financial and industrial information services organizations. Most of these organizations' information services activities are characterized by voluminous transactions that need to be processed quickly, accurately, reliably, and securely over a wide geographical area. A variety of advanced technologies including many levels of main frame, minicomputers, and microcomputer hardware, are integrated together by private and public networks, and managed by sophisticated software services to support corporate business requirements.

In the business world, this has meant cooperative data processing among computing equipment distributed among remote sites, distributed data collection, distributed data storage, distributed programming and maintenance, distributed operations, and distributed control over these resources. Corporations have, to a great extent, been forced to

implement advanced concepts and technology involving computers and communications due primarily to business competition. They have been able to achieve some real measures of success in distributed processing because of centralized planning, tight controls, and a more focused mission than those of universities. Even though some excellent work in distributed systems has resulted from university theoretical and experimental studies, academic environments have lagged well behind the business world in large scale implementation on which day-to-day operations depend. The corporations have developed distributed systems for reasons of lower overall costs to provide flexible information services that can be adapted to and evolve in their business environments. Spreading the processing out among the users, taking advantage of inexpensive mini- and micro-computers, and saving costs by reducing on-line telecommunications between terminals and central computers are attractive to profit-oriented firms.

In contrast to these corporate motives, what are the primary factors pushing academic institutions to use distributed systems? Many of the same factors in the corporate business world (other than the profit motive) may apply to administrative functions in the college or university, although there is not normally as wide a geographical dispersion of college administrative computing users. However, potential instructional and research users of academic distributed systems are very different and pose many challenging problems and opportunities.

Robinson[1] described the desired and likely features for a contemporary 1990 campus network as including:

"• conformation to a world standard for transmission protocol, both electronic and syntatic;

• transmission of information entirely in digital form at rates well above 10 million bits per second;

• transmission of voice, video, and "data" simultaneously and support work stations using any combination of them;

• interconnection to more global networks (e.g., to EDUNET, etc.);

• redefinition of work place by providing access from an employee's home, a student's work place or residence, etc.

Such a network will permit vast changes in the way people interact with computers and the applications they implement. The ability to transmit large volumes of information (e.g., a whole book) in seconds will elminiate many past barriers to full information systems utilization."

And McCredie[2] gets to the heart of the academic motivation for distributed systems:

"Creation, storage, retrieval, processing, use, and dissemination of information are at the core of

> academic effort. For this community, the convergence of computing and communication represents perhaps the most profound technical development since the invention of movable type and the modern printing press. Because information processing is so central to academics, systems that amplify human cognitive capabilities will have tremendous consequences, some of which are already visible in a few organizations."

Given the motivation and profound impact of distributed systems on organizations, how shall we plan for them? Three of the alternative approaches are:

1. Network. In this approach, the organization attempts to anticipate all communications requirements based on current operations and forecasted needs[4]. See reference papers by Trinidad[3] of INA Corp., Kelley[4] of California State University, and Shipp[5] and Webber of Brown University.
2. Applications. New applications and existing applications requiring enhancements are subjected to some kinds of technological, managerial, and feasibility tests to determine if they are good candidates to operate within a distributed systems environment.
3. Master (or Organizational) Plan. This approach is viewed from the top-down, where the mission and objectives of the organization are used as the basis for a supportive information services and distributed systems plan. Normally better suited to the business corporation, this approach is increasingly being adopted by academic institutions.

C. An Industrial Distributed Systems Planning Methodology

There is a large body of literature in the form of books, periodicals, technical journals, and case studies describing distributed systems planning and design approaches and techniques. One such comprehensive up-to-date book is by the prolific James Martin[6], entitled Design and Strategy for DDP, which is oriented to the transaction-oriented business environment, but not as adaptable to an institution of higher education.

We shall now review a top-down, organizational, or master planning methodology prepared by the author for use in large, corporate information services in the business environment. This methodology also combines network and applications planning. The reader should then examine the possibility of its adoption to the academic environment.

Distributed systems (DS) planning, as defined here, begins at the point

where distributed systems are recognized for their potential in providing greater amounts of local computing power, cost savings, and expanding the flexibility of user-oriented information systems. For the purpose of presentation, this methodology uses Yourdon[7]-style data flow diagrams to show the processes, inputs and outputs under study (see Figure 1). The five main modules are described below:

1. Identify DS Goals and Objectives. Analyze business and systems planning documents and current systems problems, along with the concepts and potential of DS to identify goals and objectives for taking advantage of DS technology and operations.

2. Determine DS Problems/Opportunities. Identify data/user environments where DS goals and objectives can be achieved. Identifies specific needs for planning and control in DS development and operation. Correlates "areas to manage" which are significant to specific data/user environments, defined in terms of how users interact with data. Examples may be:
   a. Integrated data base used by many user organizations,
   b. Independent data used by a focused user,
   c. Independent user using a shared data base.

   Based upon DS technology and DS management techniques identify system elements unique to DS and compare these to practices within the current system organization; this process identifies specific "areas to manage". These include hardware, system software, and network resources, in addition to application selection, development and maintenance. Managerial direction will then result in the definition of policies, procedures, and decisions which address DS technology and its management.

3. Apply DS Concepts and Technology. Analyze business systems planning documents to determine specific business applications where DS goals and objectives would prove beneficial in meeting business objectives. Correlate business applications (in terms of data and process requirements) with previously defined data/user environments.

4. Select DS Applications. Determine DS development and implementation strategies, apply DS selection criteria to business applications, map DS and migration capabilities to selected business applications for DS development based upon cost/benefit analysis, resources, and priority.

5. Apply DS Development Process. Develop and implement distributed information systems in a manner that maximizes service to the user community by way of a well organized and controlled system development process.

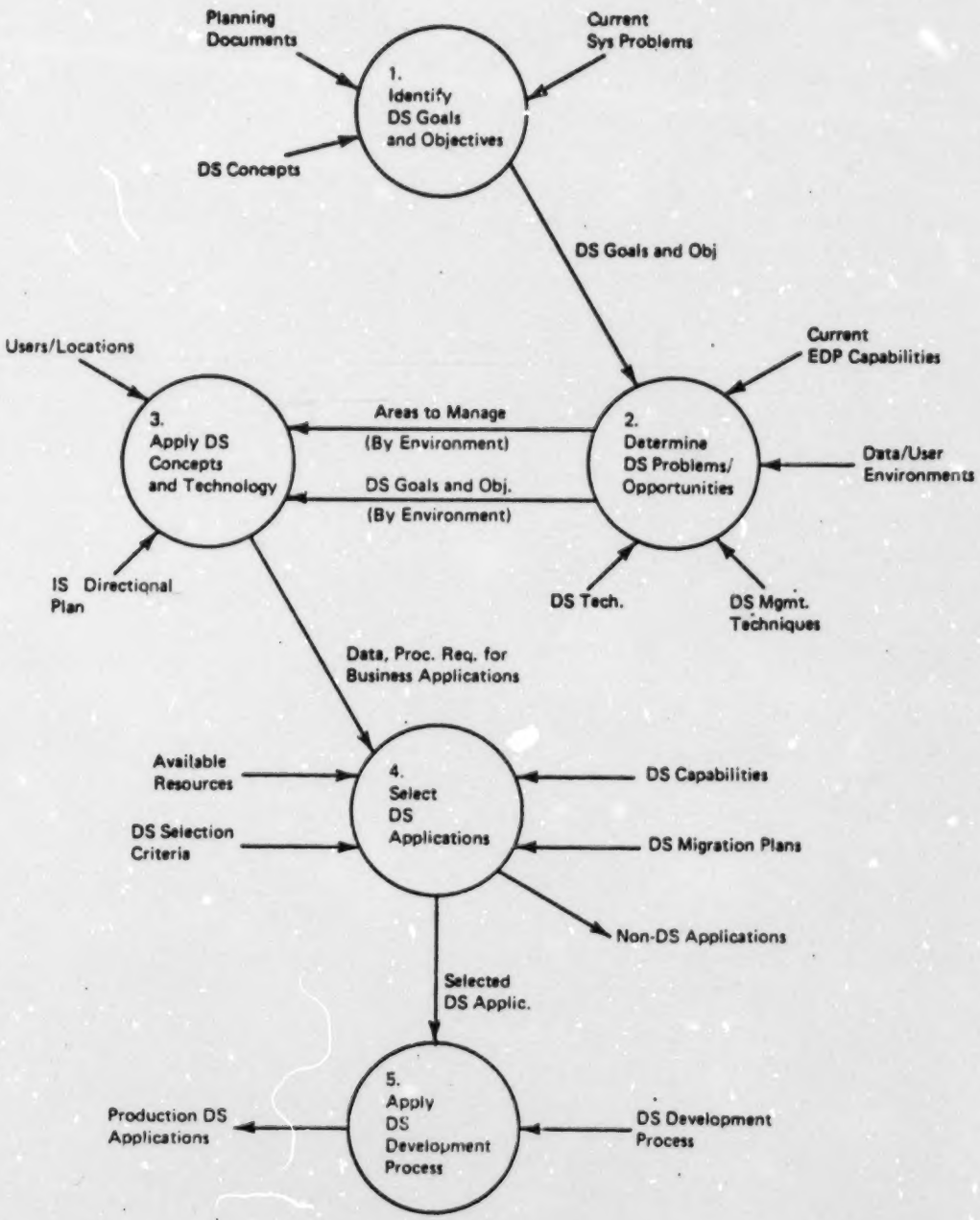

Figure 1. Planning Methodology

To what extent could such a methodology be adapted to an academic institution, and if so, to what types of these institutions? Are some of the advanced distributed planning and developments in corporate business environments appropriate to the different nature of the academy? Is it a question of technology or organizational structure? Let's examine some of these questions by addressing three academic institutional planning approaches for communications and distributed processing.

D. Academic Distributed Systems Planning

More and more, colleges and universities are realizing the importance and necessity of strategic master planning for all of computer and information services. As has occurred in industry, vice presidents for information services and technology are now being installed in academic institutions. These positions represent the concept of information as a valued resource, and several functional units are being joined to provide planning, control, and resource optimization over such areas as computing, voice, data, and video communications, mail, media, printing, and library. Thus the computer center director who formerly administered two percent of the university budget, may now command (assuming he or she has the management skills and breadth for this challenging position) at least ten percent of the budget.

More formal approaches to planning are being employed to help provide the structure to integrate all these communications-based information services. Institutional goals and missions are being examined for alternative strategies. These possible strategies are then subjected to various feasibility tests, a strategy is selected, which is followed by shorter range tactical planning for realization of budget, resource, and scheduling implications.

Dartmouth College is an example of this move to master computing and communications planning. Arms[8] describes the movement from large centralized time-sharing to decentralized computing with planning by informal consensus. This worked well for academic computing but less well for administrative data processing. The president and provost established a Task Force on Computing in 1981 to advise on the following: academic computing, administrative data processing, library computing, word processing, financial control, organizational and management structure, and interactions between different areas of computing.

Kaufman[9] of Stanford describes the complex planning of information technology there, involving numerous administrative units and advisory committees. He also notes that there is much in the academic tradition that is antagonistic to formal planning. The best results come about through enterprise and cooperation rather than central edicts. But a framework is needed, rather than a neat, comprehensive planning process. "One of the most useful images

for understanding the planning and use of information technologies at Stanford is a series of spheres of interest, some contained within others, some overlapping, and some not touching at all....These spheres of interest in some cases represent a general technological function, e.g., networking or data base management; or in other cases a specific, substantive interest, e.g., data about students, or teaching computer science." Although no master plan has been created to date, "the planning and management of information technology has evolved as a means of providing the University with knowledge of what is going on, criteria for understanding why certain things should or should not be done, and assistance in how things might actually get done."

My own institution, Bentley College, is now involved in distributed systems planning. Bentley is an independent, non-sectarian institution of 5500 full-time-equivalent undergraduate and graduate students, whose institutional mission is to produce the liberally-educated business professional. Long known for its strengths in the field of accountancy, Bentley has now assembled probably the largest business computer information systems faculty (25 full-time and 25 part-time) in the country.

As a smaller, less diverse institution than those mentioned above, Bentley is perhaps better able to plan for information services in a top-down, master approach. Last year the President[10] established an Information Services Steering/Planning Committee for these purposes:

"1. Direct and oversee the development of an information services long-range plan.

2. Serve as policy advisor to the President.

3. Report periodically findings and recommendations concerning institutional information services to the Computer Advisory Committee (of the Trustees) and the Council for Institutional Planning.

4. Review plans and budgets of the Computer Center and the Academic and Administrative Users Groups annually and to review the performance of theses bodies semiannually."

In addition to this top steering/planning committee with its two major subcommittees mentioned in 4. above for academic and administrative users, a third subcommittee (Campus Communications Committee) was formed last spring to specifically deal with all long-range communications related issues and to plan for integrated technologies. We are examining data, voice, and video needs campus-wide, as well as security, energy, library, and any other functions requiring communications both within the campus and interfacing to external information sources and destinations (i.e., regional and national computerized data bases, video instruction, etc.).

Thus Bentley is examining these questions:

1. Where are we as an institution, in terms of the College's mission, environment and current operations, with relation to and emphasis on information services?

2. Where do we want to go, in terms of mission, objectives and goals, and assumptions and risks?

3. How do we get there, in terms of strategies, policies, programs and projects, and management controls?

4. When will it be done and by whom, in terms of priorities and schedules, and organization and delegation?

5. How much will it cost, in terms of resource projections and operating budget?

Two significant recent events at Bentley as a result of this master planning are (1) the upgrading of the position of Computer Center Director to that of Vice President of Information Services, with significantly increased responsibilities, and (2) the installation of a pilot local area network as the first phase of an integrated communications network for the campus. The distributed systems methodology developed in industry and described in section C. is being considered by the author for use at Bentley.

E. Issues and Summary

As with any new technology, a number of technical and management issues are raised requiring problem resolution. Key technical issues include: data security, synchronization of data base updates, complexity of hardware and software systems, standardization of system architecture, and complexity of communications topology.

Management issues include: centralization versus decentralization of system design, implementation, management, and procurement of components in the distributed network, in addition to the need of local autonomy.

Finally, Clark[11] and Svobodova suggest that "...the fundamental issue is that computer systems should reflect the structure and needs of the problem to which they are being applied. The justification for distributed systems is that many applications are naturally distributed; it is the centralized computer facility that is often only the artifact of economic forces."

In summary, we have identified some of the main motivating factors for the movement to distributed systems, described planning approaches in industrial and in academic institutions, and finally raised some issues and implications of distributed systems that information services planners should consider.

Footnotes:

1 Robinson, Robert J., "Computers and Information Systems for Higher Education in the 1980's: Options and Opportunities," EDUCOM Bulletin, Summer 1981, p. 25.

2 McCredie, John W. (Ed.), Campus Computing Strategies, Digital Press, 1983, pp. 3-4.

3 Trinidad, José A., "Communications Planning in a DP Environment," Telecommunications, September 1980, pp. 37-40.

4 Kelley. Stephen W., "Building a Campus Communications Utility," CAUSE/EFFECT, September 1983, pp. 2-4

5 Shipp, William S. and Harold H. Webber, "Brown University Network - BRUNET," COMPCON '82, IEEE, September 1982.

6 Martin, James, Design and Strategy for Distributed Data Processing, Prentice-Hall, 1983.

7 Yourdon, Edward and Larry L. Constantine, Structured Design, Yourdon Press, 1978.

8 Arms, William Y., Campus Computing Strategies, op.cit., pp.43-66.

9 Kaufman, Paul R., Campus Computing Strategies, op.cit, pp.147-170.

10 Adamian, Gregory H., Memorandum from bentley President to Faculty and Administration, May 4, 1982 .

11 Clark, David D. and Liba Svodbodova, "Design of Distributed Systems Supporting Local Autonomy," COMPCON '80, San Francisco, February, 1980.